How Humanities Students Cope with the Technology of Virtual Harlem

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Introduction

Universities are increasingly adopting distance-learning initiatives as a means of increasing enrollments. Via distance-learning, students can take college-level courses at home by downloading course materials from the Internet and viewing video streams of lectures. For example, in early 2001 MIT began broadcasting all its undergraduate lectures on the Internet. In more creative distance-learning scenarios, distantly separated classrooms teaching related subject areas can further enrich their curriculum by engaging in collaborative classroom sessions in which instructors and students from each classroom can share their insights. Our long term research goal is to understand how to best employ advanced and emerging computer technologies to foster positive interdependence between collaborative distance-learning classrooms where insights derived from each classroom can enhance the learning goals of others. The products of this research will include the identification of potential pitfalls and the development of practical guidelines for realizing effective collaborative distance-learning classrooms.

We embarked on the first phase of this research in January, 2001, by conducting an open-ended pre-study of the receptiveness of humanities students towards email, online chat and discussion groups, high quality video conferencing, and immersive virtual reality. By "receptiveness" we mean whether the students *want* to use the technology, whether the students *can* use the technology, and whether the students *would still want to use* the technology after their initial exposure. We believe this pre-study was necessary to allow us to overcome any logistical and technical difficulties that may introduce polluting artifacts in the results of future studies; that is, we wanted to understand and devise ways to eliminate, or work around, all the idiosyncrasies of the technology—program crashes, video conferencing network stalls, et cetera. The pre-study involved the University of Illinois at Chicago (UIC) and Central Missouri State University (CMSU) in a distance-learning exercise, which bridged two English literature classrooms using a

variety of computer-based communication technologies. The course subject area was The Harlem Renaissance; the course was taught simultaneously at CMSU and at UIC. For the most part the courses ran on concurrent tracks using the same syllabus and reading materials. We used the computer-based communication technology to punctuate periods of asynchronous concurrent course work with synchronous collaborative activities, so students from both campuses could share with each other what they had learned.

This chapter will focus initially on the experiences we have garnered in exposing students to traditional computer-based communication technologies such as email, online discussion groups, online text chat, and video conferencing. Following that, we will describe experiences which expose students to emerging technologies such as virtual reality (VR)—in particular, a VR simulation of Harlem in the 1920s. FinallyFinally, we will conclude with a discussion of how we intend to proceed in future studies and how virtual reality can be used in a new field called Computational Humanities.

Integrating Technology into Distance-learning Classrooms

In the spring of 2001, the Central Missouri State University and the University of Illinois at Chicago conducted a distance-learning exercise which bridged two English literature classrooms using a wide variety of collaborative technologies. Courses about New York City's Harlem Renaissance were taught simultaneously by Bryan Carter at CMSU (English 4680: African American Literature) and by Jennifer Brody at UIC (English 350: the Harlem Renaissance). The courses ran on concurrent tracks using the same syllabus and reading materials throughout the semester.

We wanted to investigate the uses of common and exotic technologies in this collaboration. These included email, online discussion boards, chat rooms, video conferencing, and immersive virtual reality on both the CAVE and the AGAVE (Access Grid Augmented Virtual Environment) stereoscopic display wall. The following subsections describe the technologies and discuss how each of the technologies was introduced to the students of these distant learning classrooms.

Pre-course Survey

First, this study began by surveying the students' demographic information and their previous experiences, interest levels, and familiarities with a variety of technologies. We handed out this survey (in paper format) to both CMSU and UIC students in their classes on January 30. Twenty-three students at the CMSU and thirty-five students at UIC participated in this study. UIC students were mostly senior-level undergraduate students and a few graduate students. All CMSU students were graduate students. All students were familiar with computers and the Internet: 85% of students had at least one computer at home; 81% of students had an Internet

connection at home. Email was the most common technology among all technologies in this study. Online discussion boards and chat rooms were somewhat familiar to students. Very few students had experience with the video conferencing tools and no one had prior experience with Virtual Harlem and the CAVE or the AGAVE virtual reality technology. Of all the technologies, the students expressed the most interest in VR. Students were very positive about linking classes between CMSU and UIC. Most students expected benefits from collaborating; for example, a student stated that it would provide the course with more opportunities for discussion, compared to a course with grades and forced readings. In general, students stated that it would allow them to share different ideas and points of view which would help them understand materials better.

CourseInfo, Email, and Discussion Board

Based on the results from the pre-course survey, we chose the ordering of email, discussion boards, chat, video conferencing, and then immersive virtual reality to introduce the students slowly to each more advanced technology. This was based on the students' familiarity with the technologies and geared to move them from more loosely coupled technologies to interaction-intensive technologies. Both CMSU and UIC students shared the same course information website at http://courses.-cmsu.edu/courses/eng4680/. CourseInfo, powered by Blackboard, is a web-based educational tool that is currently being adopted by many universities. It allows college students to access the course information and resource archive, and it also provides personal tools for the course such as calendar, email, discussion board, virtual chat room, file transfer tool, et cetera. At the semester's beginning, Bryan Carter created accounts for both CMSU and UIC students on CourseInfo and linked the students' email addresses on this web site. Thus, the students could send email to one another via the email system provided by CourseInfo. In mid-February, we introduced the online discussion board to students, and then asked them to post their opinions to the online discussion forum by March 1. The discussion topics were:

> 1. In Schuyler's "The Negro Art Hokum," he states that the Aframerican is merely a lamp blackened Anglo-Saxon. Explain what he means. Be sure to provide ample details to support your answer.
>
> 2. Schuyler also states in the same essay that "the Aframerican is subject to the same economic and social forces that mold the actions and thoughts of the white Americans. He is not living in a different world as some whites and a few Negroes would have us believe." Do you agree or disagree with Schuyler's idea? Regardless of your answer, you must include ample evidence to support your response.

We then asked students to reply to the previous posted responses by March 20.

Virtual Harlem: Experience and Evaluation

Instead of following our initial plan, we decided to introduce Virtual Reality next. We arranged for the students to experience Virtual Harlem twice. In their first encounter they simply toured the VR space and discussed their experiences over a video conference, held the following week. In their second encounter we had them actually work in the VR space by having them deposit virtual annotations (described later) in the space. This was followed-up by an online chat session, and later, another video conference session to discuss their experiences. Both encounters are described in detail below.

On March 27, students in both classes visited Virtual Harlem. Students were asked to explore Virtual Harlem and take notes on their experience as they normally would during class. The students were organized into three groups. Half of the UIC students were placed in the CAVE, the other half used the AGAVE, while all the CMSU students watched a video-taped movie of a walkthrough of the environment. None of them had prior experience with Virtual Harlem or the CAVE / AGAVE technology.

Virtual Harlem is a virtual reality reconstruction of Harlem, New York, from the 1920s to the 1930s, designed to help students "experience" the neighbourhood's life and culture. Designed as a supplement to a selection of literary works from the era, the current Virtual Harlem prototype allows students to be immersed and engaged in the historical context of their coursework. Students are able to walk down the streets of Harlem and see the shops, homes, theatres, churches, and businesses as well as the writers of that period. They can hear music in the Cotton Club, political speeches of figures like Marcus Garvey, or thought-provoking poems by Langston Hughes.

The Virtual Harlem project was originally conceived in 1998 by Bryan Carter at Central Missouri State University (Carter 1999) and the first prototype was created in collaboration with Bill Plummer at the Advanced Technology Center (ATC) at the University of Missouri. A year later, the University of Illinois at Chicago contributed to the Virtual Harlem project by translating the Harlem experience to a fully immersive environment – the CAVE. The CAVE is a multi-person, room-sized, high-resolution, and projection-based immersive virtual environment system. Computer-generated images are rear-projected in stereo onto three walls and the floor, and viewed with stereo glasses. An electromagnetic tracking system attached to the glasses and the wand (3D mouse) allows the CAVE to determine the location and orientation of the user's head and hand at any moment. This information is used to instruct the Silicon Graphics Onyx that drives the CAVE to render the images from the spectator's point of view.

Virtual Harlem is also deployed on the AGAVE stereoscopic dis-

play wall. AGAVE provides passive polarized stereoscopic three-dimensional graphics using low-cost projectors and a Linux PC. This is the first time we have been able to bring our high-end visualization technology (typically costing between $150,000 and $2,000,000) to a cost low enough that it can be deployed in classrooms (around $11,000). AGAVE was designed to augment the Access Grid (a multi-site video conferencing tool) to allow collaborators to immersively share three dimensional content, such as scientific and engineering data, in conjunction with two dimensional Access Grid content. With AGAVE, students wear inexpensive ($0.30 to $12) 3D movie glasses to view the immersive content. If desired, an additional 3D tracking system and pointing device can be incorporated to support 3D interaction. In this study, we used a regular video game joystick on the AGAVE.

During the Virtual Harlem session, UIC students (using either CAVE or AGAVE) navigated around the virtual space with the joystick for about 5 to 10 minutes; there was no particular time limit imposed. Typically 3 to 7 students walked around the Harlem space in a group. Meanwhile, CMSU students watched a 10-minute long video movie that contained the Virtual Harlem walkthrough with Carter's narration. After exploring the space actively in the CAVE/AGAVE at UIC or passively though video at CMSU, the students wrote evaluations of what they observed in the Virtual Harlem experience and what they thought would be interesting to see in the future. They also compared this experience in Virtual Harlem to what they read about Harlem.

Figure 1. Virtual Harlem running on the AGAVE system in the classroom at UIC next to a remote view of Carter's classroom at CMSU.

Video Conferencing on the Virtual Harlem Experience

In the week following the Virtual Harlem visit, a joint class between CMSU and UIC was held via video conference (See Figure 1). Brody's class took up most of the Access Grid room at the Electronic Visualization Laboratory at UIC. The Access Grid room is fully equipped with multi-site, high bandwidth video conferencing. At the front of EVL's Access Grid room are three plasma screens that are used to display video conferencing channels. The middle plasma screen is also connected to the Polycom video conferencing system. In this study the Polycom was used between Brody's class at UIC and Carter's class, in a multimedia room, at CMSU. The large size of the plasma screen made Carter appear life-sized allowing him to easily establish a presence in Brody's class. Students would request the microphone to address Carter's class. This was the first time students in both classes had met each other. The two classes compared what they saw in their Virtual Harlem experience with what they had read in their classroom reading materials. This video conferencing session lasted for an hour. The specific discussion questions we asked of the students included:

1. How does seeing a relatively empty, built environment affect your reading of "Harlem"?

2. How would you describe and analyze the way you were able to manipulate the environment? Discuss the ways your perspective shifted as you moved through the virtual space.

3. How did you imagine yourself "in" the environment? Did you think of yourself as an embodied or disembodied subject? Did the environment make you see/think about the material we covered in class that was presented in other media? If so, how did the "experience" of VR change your thoughts about such material?

Chat Room

The week after the video conference, we scheduled an online chat session using Virtual Classroom in CourseInfo. Students met in a chat room to generate ideas about possible "annotations" that they could create in Virtual Harlem. They met twice, each for an hour, during that week. Only a few UIC students participated in the sessions. All the text messages for the chat sessions were recorded and stored in an archive, sorted by date, and hence can be retrieved from the CourseInfo web site.

Virtual Harlem Annotations

College students are familiar with annotations. They use them to bookmark important sections of a text, make interpretive remarks,

and do fine-grain highlighting to aid memory. Annotations help them understand a text and to make the text more useful in future tasks. We can similarly use annotations within the virtual environment for a variety of tasks. Enhancements to Virtual Harlem include an annotation tool that allows students or instructors to leave annotations throughout the virtual space that can be retrieved by themselves or others in future visits. Virtual annotations are recordings in virtual reality where both the person's hand and head gestures, as well as their voice, are captured. Since the CAVE is automatically capturing the position and orientation of the user's head and hand, the only additional burden on the user is the microphone which records their speech. Since Virtual Harlem is a three-dimensional space, the head and hand gestures allow the user to point toward landmarks in the space and give more nuances to their speech. When the annotations are played back, an avatar appears to re-enact the annotation (Figure 2). Students were encouraged to form their own opinions on the things they saw and heard in the Harlem experience and then to leave annotations that other students could further comment on with their own annotations, creating a 'feed-back' loop. Through this process, we anticipated that students and instructors would spur discussion and

Figure 2. An annotation in Virtual Harlem appears in the form of an avatar (a representation of the person leaving the annotation) which can look or point at locations while talking.

debate in the classroom or in the VR world.

On April 17, UIC students were asked to create a short interactive narration in Virtual Harlem using the VR annotation tool. They were asked to leave an annotation in Virtual Harlem that would enrich the experience for future students taking this course. A printed map was provided to help students find locations of interest in Harlem where they could leave annotations. Each student would decide on a location for the annotation and then create a brief two to three minute audio and gestural recording. The students were organized into three groups: students who were previously in the CAVE were placed on the AGAVE; students who were previously on the AGAVE were placed in the CAVE; and CMSU students were only able to review the annotations via the web.

Video Conferencing on Virtual Annotations

The second video conferencing session took place on April 24. This time, students conducted a discussion on their experiences at making annotations in Virtual Harlem as well as their general opinions about this distance-learning classroom exercise. Originally we had intended a one-hour conferencing session, but—due to technical difficulties—we could only hold the discussion for 30 minutes.

Results and Discussions

This study attempted to investigate the patterns of usage with the technologies employed in a semester-long distance-learning exercise. We wanted to determine which technologies would be most suitable for specific tasks in a collaborative learning environment and at which phases the groups decided to meet. For example, we expected that email would primarily be used for initial planning stages of the class and sending messages in general. Mainly we observed students using these technologies in their classrooms. We also recorded the students' usage of the technologies. CourseInfo provided the statistics about percentages of use, e.g. total number of accesses per area, over time, by user, et al. Similarly, a logger program collected the activities of the students in Virtual Harlem, and hence it allowed us to track when a user entered and exited Virtual Harlem, where they visited, when they stayed longer, etc. In addition, we gathered classroom artifacts, such as printed annotation notes and classroom essays. Finally, we tried to correlate the results from all collections, such as pre- and post-course surveys, observational notes, video recordings, and student classroom artifacts.

The Function of Technologies and Their Uses

Email

Email allows users to exchange text messages and computer files

over a communication network such as the Internet. Teachers and students exchange course materials, assignments, and messages via email. One of the unique features of email is that it can be either a one-to-one communication channel, or it can easily be a one-to-many communication channel. While email can be nearly instantaneous, it is more known as an asynchronous collaboration tool. In our study, the students generated very few email messages. In fact, email was never used for the communication between students in two classrooms nor between teacher and students in opposite classrooms. Instead, it was used for the communication within the same classroom, such as for general classroom announcements or technical support. For example, several UIC students sent email to report their problems with getting into the CourseInfo website or accessing online discussion boards. Perhaps we did not give attractive reasons for collaboration between students in two classrooms. Our initial plan was that UIC and CMSU students would team up to work on group projects at a distance, but no one volunteered. It was mainly due to inadequate guidelines and students' unwillingness to engage in collaborative group work over distance.

Discussion Board

A threaded discussion forum, such as CourseInfo's Discussion Boards, allows the users to conduct a long term, topic driven discussion. Threaded discussion spaces provide a mechanism for asynchronous discussion where the structure of the discussion is reflected in the interface. Discussions are easily moderated and directed where the instructor or moderator can keep the discussion on topic. Unfortunately, the online discussion board in this study was not fully utilized as a forum to share the students' perspectives or knowledge. Rather it was being used for submitting short essay assignments online. This may have made students feel somewhat burdened with the additional tasks of learning and using an Internet-based collaborative technology in comparison with the simpler matter of turning in a paper in a regular classroom. Of the sixty-one total messages posted on discussion board two, forty-four were original postings and only seventeen were response postings. Furthermore, no students posted more than two messages on the discussion board. Although the postings were read often, there was very little interaction in terms of online responses to ideas. The problem, we believe, is attributed to the fact that the incentive for posting a message was artificially created—i.e., the instructor asked them to post something. It was not something that the students felt compelled to post out of their own curiosity. Discussion groups traditionally have been motivated by people with the same interests who want to share them. This was clearly not the case here.

Chat Room

A chat room allows users to have a real-time discussion by typing text on the computer. It is a public forum where members can express their ideas immediately. While a chat session is much more difficult to moderate, like a real life conversation it is also more intimate than online discussion boards. In order to enter the CourseInfo's virtual classroom, students have to have a Java-enabled browser. Most recent web browsers support Java; however, some students reported that they had difficulty entering the virtual classroom on CourseInfo, and we suspect that it was probably because the web browser they used might be Java disabled. The CourseInfo's virtual classroom provides a text chat session, a shared whiteboard, and a shared web navigator. We noticed little use for these tools during the chat session.

In this study, only a few UIC students participated in each chat session. Only three students, plus Brody and one of the authors, participated in the first chat session. Three students participated in the second chat session. One of the reasons for such low participation can be attributed to inadequate scheduling of the event: We had scheduled the first chat session on Wednesday from 2:00 pm to 3:00 pm, and the second one on Friday from 9:00 pm to 10:00 pm. This may have conflicted with other classes on Wednesday afternoon, and students may have been out on Friday night. However, those that did participate in a chat session were satisfied with their participation in this event, where they each had a chance to voice their opinions. Participating students expressed positive opinions about chat in the post-course survey.

Participants raised interesting ideas for virtual annotations, such as a poetry reading, an art discussion akin to the Harmon Foundation room where Harlem artists could talk about their works, and adding a rent party a la Emma Lou to compare to Helga Crane's party. Other ideas included a discussion with Aaron Douglas and how Alain Locke's philosophy influenced their work, a story of the average Joe in Harlem, and a story of white Harlem scholar Van Vechten. One of the participants stated that he wanted more times scheduled to talk in a chat room with CMSU students.

The size of the participants is another important factor. As five students participated in the chat session, there was sufficient critical mass to hold a discussion, but not so many to be difficult to follow.

Video Conferencing

The chief advantage of video conferencing is that it is immediate and real-time. Video conferencing allows a professor to address a large number of students at distant locations. In our study, the classrooms at UIC and CMSU were connected through the Polycom video conferencing system so the students could see and speak to each other directly.

The students reacted positively to the video conference. Carter and Brody moderated the session, and students at both ends active-

ly exchanged opinions over the video link. They discussed numerous ideas about what they saw in the Virtual Harlem experience and compared this experience with what they had read in their classroom reading materials. Students suggested adding more interactivity, sound, and events like a rent party in Virtual Harlem. Students also wanted a means to role-play in Virtual Harlem where they could choose to be a person of a different race, gender, or age, and experience Harlem through new perspectives. Students compared their experiences in Virtual Harlem between the CAVE and AGAVE and found the CAVE experience to be richer. At the end of this video conference, they brought up the virtual annotations topic, then they decided to discuss themin-depth in chat sessions scheduled for the following week.

Technical support personnel at each university were involved in all video conferencing sessions. There was a 30-minute technical check of network bandwidth and audio quality before the joint class started. During the session, the technical support person panned and zoomed the camera to best capture the audience's participation. However, we noticed that UIC students were a little bit shyer speaking in public than the CMSU students were. We believe it was because we had to pass around a microphone in the Access Grid room whereas the multimedia room at CMSU was equipped with several ambient microphones, which allowed students to converse naturally. We also believe that the fact that the classroom size at UIC was almost twice as big as the CMSU class might have been another influential factor. During the video conference, CMSU and UIC students exchanged their opinions by turns, but, due to the bigger classroom size, UIC students had fewer opportunities to speak.

The outcome of the second video conference was less fruitful. Halfway through the conference, we experienced network difficulties, and the video and audio began to break up. In such situations, we would normally switch audio to a conventional analog phone conference so that the meeting could continue, but CMSU's classroom was not equipped to handle the contingency. When audio began to fail, as expected the meeting quickly broke down.

Virtual Reality

The definition of VR is much in dispute, particularly in the education community – it ranges from the experiences of a CAVE to those of web surfing. We restrict the term VR to describe an experience where users are immersed in a virtual space and interacting with virtual artifacts through a head-tracked, stereoscopic display – such as in the CAVE. There have been many immersive virtual reality applications built and tested for educational purposes. Many of these educational VR applications are aimed at teaching abstract concepts such as physics, mathematics, and the environmental sciences [Dede 1997, Winn 1992, Winn 1995]. Some address general knowledge acquisition and concept formation through the experience of a first person point of view [Allison 1997, Johnson

1999]. Some are based on a collaborative virtual environment where students learn materials while interacting with other students or teachers [Jackson 2000, Johnson 1998].

A collaborative virtual environment allows the users to interact with other users and/or artifacts in a virtual environment. People in remote locations can share collaborative learning experiences, work together on designing systems, or perform a complex group task in this environment. Users are explicitly represented to each other within a shared space and should be free to move around within this space, encountering each other and also objects and information of common interest.

Exploration of Virtual Harlem

In the best of situations, we would have liked the students from both classes to experience Harlem in VR systems that are networked to each other. We have already done this in the past with great success, between VR systems around the world. However, since CMSU did not have a VR system, the students there (17 of them) experienced Harlem by watching a 10-minute pre-recorded video tour. Meanwhile, at UIC, half of the students were placed in the CAVE (16 students participated), and the other half used the AGAVE (14 students participated). We collected all the students' essays about their Virtual Harlem experience after the visit. Overall, most students reported that the Virtual Harlem experience was valuable because it helped give them a three-dimensional frame of reference for the subject they were studying. For example, they could identify small neighborhood stores, theatres, clubs, people, etc. Some students felt as though they were "entering history". Many sounds and Harlem personalities (e.g., old men giving advice on the street) further enriched the experience. However, from the description of Harlem in their book readings, students expected more bustle in Virtual Harlem. They wanted more realistic details such as noises, crowds, everyday conversations on the streets, and traffic, and more interactions with things and people in the environment. They also wanted more building interiors to explore, such as the Apollo or the Savoy. Interestingly, some UIC students pointed out that there needed to be more literary content in the virtual environment, i.e., more Harlem characters reciting poetry, or a parlor room with literary icons. CMSU students were more interested in witnessing historical events, such as attending a Harlem rent party or the day that Big Jim's Regimental Band came through after returning from the war.

UIC students were given an unguided exploration task – they could go wherever they wanted on the streets of Virtual Harlem. In the CAVE, only small groups of students, at a time, could experience Harlem and so they interacted with the surroundings and with each other much like friends touring a new city. Some students mentioned that there needed to be a virtual tour guide or tour bus that would announce street names and help direct them towards interesting sights. Also, some thought a printed map would have

been a useful addition. In general, students felt that the experience in the CAVE was more satisfying than the experience on the AGAVE. Students seemed to be more engaged in the CAVE since they were surrounded by a panoramic view of life-sized buildings and people. On the AGAVE, students felt as though they were watching a 3D movie.

Results on trace patterns in the CAVE verses the AGAVE

All activities in the CAVE were recorded onto videotape and logged onto a file. Each log included a trace of a student's navigation through Harlem. The trace would record how long they spent in each area of Virtual Harlem, how far they went, where they went, where they stood and looked around, etc. Interestingly, individual snapshots of the path traces showed quite different navigation patterns between users in the two VR systems. The students in the CAVE tended to stay stationary most of the time, whereas the students using the AGAVE moved all over Harlem (Figures 3a & 3b).We believe this is primarily because the AGAVE did not provide a panoramic field of view, as in the CAVE, and hence students had to traverse each direction at a street intersection to orient them.

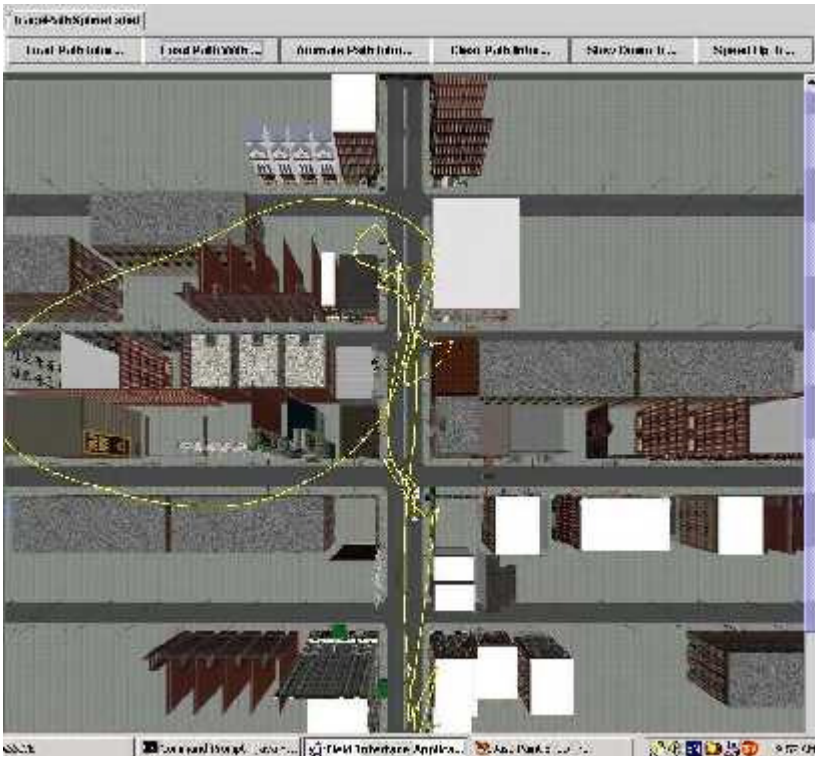

Figure 3a: The trace patterns of students walking around Virtual Harlem in the AGAVE.

For example, they were frequently searching for notable Harlem landmarks such as the Cotton Club or the Lafayette Theatre. In the CAVE they would simple turn their head in each direction to see if the landmark was in sight. Without a panoramic view, they had to perform a 360-degree turn, which can take about 30 seconds. Often from lack of patience they did not perform a full rotation and hence would miss the landmark; they would instead head-off in the first "promising" direction. This often got them lost and so they had to backtrack often.

Observations on the Virtual Harlem annotation task

UIC students were asked to create a short interactive narration in Virtual Harlem that could be used to enrich the experience for future students taking the course. The narration consisted of recording a student's voice, head, and arm gestures. We have collected fifteen annotations in the CAVE and seventeen annotations on the AGAVE. Each annotation usually runs for an average of two or three minutes. The session took about three hours for all students creating annotations in the CAVE and on the AGAVE. Usually two or three students were paired up to make an annotation in Virtual Harlem, and they did several trials on recording an annotation before leaving one permanently. Some students left more than one annotation, while some made an annotation as a group. Originally, we had hoped that the students would leave a spontaneous narration reflecting an opinion of some aspect of Harlem, but to ensure participation in the activity, Brody wanted the students to prepare something in advance; hence, the annotations that were finally made sounded more stilted rather than natural. On average it took a student about 30 minutes to choose and create a two to three minute annotation. During this time, the students all seemed to enjoy helping each other in the process. Some students tried outlining their annotations in a notepad so they could remember what to say. Most students took off the 3-D glasses when they were making the annotations as the glasses made it too dim to read from their notes. Since the head tracking system is attached to the 3-D glasses, it was difficult to record any of their head gestures. Furthermore, the students did not wear the wireless headset microphones because they wanted to record several voices together as a group. In the future, we will have a boom-mic operator dangle a microphone near them to make the recording.

Many students, particularly those who were in the CAVE, said they enjoyed leaving virtual annotations. Some students stated that putting together the annotations made it possible to utilize what they learned in class in different and more creative ways. Some students said this activity made them feel as if they were a part of Virtual Harlem because they had contributed something to the environment. On the other hand, some students felt self-conscious about leaving behind recordings that others would some day discover.

Issues in the Distance-learning Classroom

This study investigated how to integrate a variety of computer-based communication technologies that allow collaboration between two remote classrooms teaching related subject areas, where instructors and students from each classroom can share their insights. This distance-learning classroom exercise made the instructors redesign their courses to include the collaborative learning goals, the shared course syllabus and reading materials, and decisions of how to incorporate these various technologies into their classroom. Overall, in the post-course survey, students gave positive responses to this exercise. Students said it was a unique opportunity for them to meet classes elsewhere, which seemed it extended the traditional classroom boundary. Students said they could share each other's perspectives about some topics they learned in their respective classes. Technology in general helped to bring both classrooms closer.

However, students also responded that they wanted more collaboration between two classes. Students felt that there should be more interaction or communication between the two classrooms. Some UIC students suggested more frequent and casual chats with CMSU students for the future distance-learning classroom. Students suggested the future distance-learning classroom should have more opportunities to work with remotely located students. It seemed we did not give an attractive reason to draw students naturally into collaboration over technology. Instead, it seemed we just forced them to use technologies; posting messages on the discussion board was just one example of such failures. Thus, it is important to have a believable reason that students between classrooms will benefit from collaborating. The following issues also need to be addressed in order to conduct a successful distance-learning classroom:

1. Equalization of technology between classes is important or else both ends can get frustrated because of quality differences in the collaboration.

2. Equalization of classroom size, so students at both ends are able to get to know each other.

3.Equalization of students' initial familiarities with the technology need to be documented. It seemed the students' comfort levels affected the patterns of utilizing technology. The post-course survey results revealed that CMSU students utilized CourseInfo a lot more than UIC students did. Most UIC students had not used CourseInfo before taking this course. They used CourseInfo mostly for the assignments and the discussion boards.

4. More organization, preparation, and notice given, or questions and statements ready for the interactive ses-

sion beforehand. Other recommendations include the caution that institutions should strike a balance between traditional and technology-based delivery, and be prepared to alter the balance over time as the needs and expectations of students change.

5. The need for more available technology in the home and that is inclusive to everyone. The technology should be inexpensive so that more institutions could adopt it. The technology should be incorporated in a regular classroom, i.e. the technology should become a part of the classroom environment. In our study, the Humanities class had to move to the Engineering building for the interactive session, which created difficult learning and management problems for teachers.

6. Both teachers have to be well trained and ready to push the technology for the interactive session in the distance-learning classroom; otherwise, one end or both will fail. Distance-learning classrooms are extremely difficult to coordinate compared to single classrooms that use technologies.

7. More encouragement for using technology frequently. Students tended to use technology more when forced, but they disliked when they were forced to use it. Compelling reasons for using the technology must be devised to encourage use.

In this distance-learning exercise, we also wanted to investigate the utilization of each technology. We believed the collaboration should occur in a number of phases and a particular technology would be most suitable for each phase. However, as we discussed in the above section, we found that there were not enough uses of technology between students in two classrooms to understand the functions of each technology and the interactions of multiple technologies in their collaboration. Instead, the study results revealed that it is important to order introducing technology properly in the distance-learning classroom. In the study, we began by using technology that the students were most familiar with, such as email, and then gradually introducing them to more advanced technologies, but this turned out to be inefficient. We suggest that the order should be started with the technology that provides the best way to establish natural communications to create reasons for further communication, which almost reverses our initial plan. We believe the following sequencing of the use of technology is the way to go for a distance-learning classroom where students at a distance are required to complete a joint project together. But, first of all, it is important to provide a collaborative problem between two student groups where it is beneficial for them to collaborate; otherwise the collaborative technology won't work. Then, introduce students to:

1. High-end VR to stimulate interest of learning contents.

2. Initial introduction phase with video conferencing, which will build the trust and social bond between them.

3.Project planning phase with frequent online chat as a mechanism to identify topic areas of interest for a joint class project or small private video conferencing meeting rooms for generating project ideas. It may also need other synchronous groupware tools, like shared whiteboard or shared web browsing.

4.Project work phase with online discussion groups or email. This phase is usually performed independently and asynchronously between members in a group. Online discussion groups can be used for a subgroup's focused discussions because deep queries that cannot be answered in large audience chat. The shared data repositories are also useful additions.

5. Regularly synchronized meetings with video conferencing or other synchronous tools (e.g., chat or VR) to update the project progress and check timelines.

6. Project presentation phase with video conferencing and VR, where VR can be used as a stage for students to present their project results.

Conclusion and Future Work

The Council for Higher Education Accreditation updates reports about distance-learning in higher education approximately once every six months. The report reviews several current issues in distance-learning, including recent surveys about the expanding uses of technology in higher education, virtual universities, and recent policy developments. Update number two reported that previous research on distance-learning focused mostly on the impact of individual technologies rather than on the interaction of multiple technologies. It also indicated that the higher education community still has much to learn regarding how and in what ways technology can enhance the teaching/learning process.

This study focused on investigating the effects of using multiple technologies in a distance-learning classroom to enhance a student's learning experience. The main goal of this study was to understand how to best employ existing and emerging computer technologies to foster positive interdependence between collaborative distance-learning classrooms, which will be more effective than the traditional single classroom-based teaching model.

The result revealed that students were able to broaden their perspectives through this distance-learning exercise. It also revealed that it would have been successful if there were more collaboration between students and more exposure to the technologies than what we provided in this study. This preliminary study showed the potential benefits of integrating a variety of computer-mediated communication technologies to establish a collaborative distance-learning classroom. We believe this new paradigm will become common in the future, and hence it is important to understand how technology can enhance the collaborative learning process better.

In this paper we have mostly discussed the design issue—how to improve a distance-learning classroom. Obviously, this kind of exercise requires more commitment and collaboration from teachers and students as well as technical providers. We would like to continue to explore the pedagogical issues in a distance-learning classroom in the future. The next study will be designing and evaluating the project-oriented distance-learning classrooms over the variety of computer-mediated collaborative technologies.

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